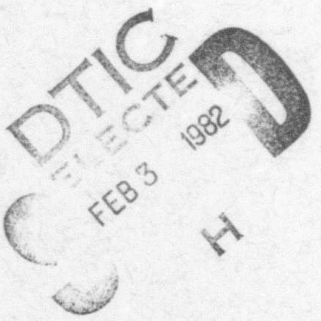
SYSTEM PLANNING CORPORATION

SUMMARY OF QUICK-RESPONSE RESEARCH AND TECHNICAL ANALYSES

SPC 771



November 1981

Anthony J. Provenzano

Sponsored by
Defense Advanced Research Projects Agency (DoD)
DARPA Order No. 4085
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ABSTRACT

This report highlights and summarizes work conducted by System Planning Corporation under Contract MDA903-81-C-0124 for the Defense Advanced Research Projects Agency. The effort included work on target acquisition, obscurant technologies, seeker requirements, antiship munitions, unguided weapons, materials technologies, indirect fire support, and air defense flexibility.

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CONTENTS

SUMMARY OF QUICK-RESPONSE RESEARCH AND TECHNICAL ANALYSES

A. PURPOSE

System Planning Corporation (SPC) completed 36 quick-response research and analytic tasks for the Defense Advanced Research Projects Agency Tactical Technology Office (DARPA/TTO) under Contract MDA903-81-C-0124. This report highlights and summarizes the major activities conducted by SPC under this contract and provides a list of reports that were submitted to DARPA/TTO. In addition, SPC provided numerous briefings and other support that did not result in written documentation.

B. BACKGROUND AND SCOPE

For the past several years, SPC has provided DARPA with analytical support in the areas of land, naval, and air warfare. The current contract focused on similar work. Some of the specific topics that SPC addressed are target acquisition, obscurant technologies, seeker requirements, antiship munitions, unguided weapons, materials technologies, indirect fire support, and air defense flexibility.

SPC's analyses, initiated on a task-order basis, provided information for use in assessing technological initiatives and in preparing investment strategies that would maximize the use of funding allocations. Task results were documented in reports or briefings, as specified by DARPA.

C. SELECTED TASK SUMMARIES

1. Long-Range Area Air Defense Systems

The purpose of this task was to examine the feasibility and potential of an advanced modular, intermediate- and long-range air defense system. SPC investigated bistatic and monostatic radar surveillance, acquisition, and tracking techniques as candidates for alternative system concepts, including modular mobile missile configurations and advanced guidance.

Because effective and timely air defense weapon systems development and deployment are hampered by funding limitations, uncertainties in technologies and threat projections, and long development cycles, SPC designed a hypothetical air defense system in accordance with the U.S. Army Training and Doctrine Command (TRADOC) Air Land Battle Concept for the 1995-2110 time frame. The study defined and provided preliminary cost estimates for a proposed long-range area air defense system (LORAADS) concept that could be used by DARPA to determine the necessary technology base for developing an effective long-range tactical air defense system. The system would be used in 1995 and beyond to counteract tactical air-breathing and missile threats including conventional, chemical, and nuclear munitions.

SPC assessed associated development risks and recommended an approach for technical development of an effective long-range tactical air defense system. SPC also investigated the potential for developing a multistatic radar mode using ground transmitters and receivers. Several recommendations were made concerning capabilities that need to be developed. SPC suggested that DARPA explore these areas and perform a cost/benefit analysis of multistatic airborne radar techniques. This effort is detailed in SPC Report 714, Long-Range Area Air Defense Systems (LORAADS) Concept Study.

2. Advanced Antisubmarine Weapons

SPC conducted technical analyses and provided recommendations for future work in the area of advanced antisubmarine warfare. This study included an independent review and analysis in the areas of hydrodynamics and propulsion systems engineering for the Squint Mode Air-to-Surface Homer (SMASH) program.

This work and a review of Naval Surface Weapon Center presentations and analyses resulted in preliminary conclusions and recommendations concerning the 5-inch SMASH device. SPC's effort is documented in the report, Advanced Anti-Submarine Weapons.

3. Synthesis of Advanced Materials

The potential military application of advanced materials is a topic of significant interest to DARPA and was one of the major studies performed under this contract. SPC surveyed selected advanced materials processing technologies and developed planning criteria for a tentative research program that would produce improved new materials with desired mechanical properties. As part of this effort, SPC organized a two-day workshop that was attended by representatives from universities, national laboratories, and private research organizations.

The workshop discussed the potential of new processing concepts to synthesize existing refractory materials at lower costs than older processes and to produce new materials. Two alternative process concepts now exhibit sufficient promise to warrant further development. One is dynamic compaction of powders (DCP), and the other is self-propagating, high-temperature synthesis (SHS). Extensive work has been done by U.S. industry in the area of DCP development, but in the case of SHS, virtually no laboratory experiments have been conducted by U.S. companies. SPC outlined a comprehensive materials synthesis program, one of the goals of which would be to produce bulk quantities of refractory materials by the mid- to late-1980s. The report produced under this task, Synthesis of Advanced Materials, suggests that there be further evaluation of these new technologies and approaches for transferring favorable materials into military hardware applications.

4. Advanced Obscurants Technology

DARPA/TTO recognizes the need to monitor the research and development of advanced obscurants in view of their possible effects on advanced seekers/sensors and the potential emerging technological opportunities for their use

as countermeasure or counter-countermeasure devices. Therefore, SPC was tasked to undertake a study of obscurant technology and identify high-payoff opportunities that should be exploited. In the conduct of this effort, SPC met with personnel engaged in advanced obscurants research and attended a symposium on smoke obscurants. Specific findings and recommendations of this work are presented in SPC Report 751, Advanced Obscurants Research and Development.

5. Division Support Weapon System

SPC was tasked with evaluating nine rocket and missile concepts that U.S. industrial firms submitted as candidates for a Division Support Weapon System (DSWS). A lack of details precluded a comparative evaluation of the candidates. Instead, each was categorized as a guided missile; an unguided, corrected rocket; or an unguided, uncorrected rocket. Each candidate was then rank ordered within one of these categories.

The general evaluation criteria were technical validity, correctness of system integration approach, and cost. In addition, the four functional objectives of responsiveness; survivability; terminal effects; and reliability, availability, and maintainability (RAM) were included in the evaluation. All concepts were found to be technically valid, but the guided missile systems were judged to be higher in risk and more limited in target array than the rocket systems. A preliminary conclusion was reached regarding the best of the corrected and uncorrected rocket systems.

The guided concepts were judged to be not viable for a DSWS role, and it was recommended that additional cost, performance, and RAM data on the rocket concepts be obtained before a final comparison is made. This effort is documented in SPC Report 720, A Technical Evaluation of Industry Responses to the Rocket/Missile Solution of the Division Support Weapon System (DSWS).

6. Advanced Close Combat System

SPC conducted a critical review of the Advanced Close Combat System (ACCS) concept and assisted in assessing whether an integrated missile/combat

vehicle might be preferred to a cannon-equipped vehicle. The ACCS concept evolved from DARPA's efforts to develop advanced weapons concepts that could increase the effectiveness of light, mobile forces.

The ACCS configuration is described in SPC Report 646, Advanced Close Combat System (ACCS), A Light, Missile Armed Armored Vehicle. Because the ACCS design applies several unconventional technical and operational innovations, a broad critical review of the concept by the government and industry was deemed to be necessary. The concept was presented to personnel in 19 government agencies and 21 industry engineering groups. The review resulted in:

- Near-unanimous agreement that the concept has high potential operational utility
- Strong support of the ACCS concept as an alternative to several ground vehicle-mounted missile systems (e.g., TOW, ITV, IFV and CFV)
- Diverging views as to whether the ACCS concept would replace or complement combat vehicles with a cannon as primary armament
- Broad consensus that the concept was technically feasible at moderate to high risk
- Numerous suggestions for design alternatives
- Strong support for further development of the ACCS concept in parallel with the development of a light armored combat vehicle with a cannon as primary armament.

As a result of this effort, SPC recommended that DARPA initiate an ACCS program by inviting conceptual designs from industry. A complete presentation of this effort is provided in SPC Report 688, A Report of Results of Critical Review of the Advanced Close Combat System (ACCS).

7. Simulation of Indirect Fire Munitions

SPC was tasked to identify current or evolving technologies that could be employed to safely simulate lethal combat munitions. The study focused on the problem of artillery or mortar indirect fire simulation because (1) troop safety constraints make it the most complex simulation to perform, and (2) there exists a well-recognized, documented requirement for such a simulation.

This assessment excluded all simulations that could cause injury as a result of velocity, weight, overpressures, or fragmentation effects in the target area. Techniques or devices that have a fire or dud-producing potential also were eliminated, as were those casualty assessment approaches that are overly complex, expensive, or do not address other simulation requirements.

SPC compared two simulation concepts proposed by industry with an ideal simulation. A third concept was developed in part on features that were identified in proposed concepts and from suggestions of the study analysts.

The study concluded that:

- It is feasible to develop a lightweight, low-energy-at-impact signature device in compliance with safety criteria.
- It is not possible to achieve a true ballistic simulation of a "hard" projectile by using a lightweight projectile.
- It is not possible to fully simulate actual firing at the gun position that includes the crew tasks of loading, laying, firing, and relaying following recoil.

As documented in SPC Report 687, An Assessment of Technologies for Simulation of Indirect Fire Munitions, it was recommended that DARPA and the designated U.S. Army proponent for indirect fire simulation jointly sponsor a research and development project for prototype development and test of:

- Lightweight training projectile designs
- Nozzleless rocket motor(s)
- Soft impact and no impact terminal effect and casualty assessment devices.

8. Millimeter Wave Conference

SPC organized the 9th DARPA/Tri-Service Millimeter Wave Conference held at the Army Missile Command in Huntsville, Alabama, on 20-22 October 1981. The purpose of the conference was to provide a classified forum for disseminating information on current millimeter wave (MMW) technology to those who are involved in the military application of this technology.

Fifty-nine papers were selected for presentation. They addressed such topics as the Armed Services' MMW programs, military target signatures, atmospheric transmission measurements, MMW communications, and countermeasures. More than 350 persons attended the conference. A record of the conference activities is being assembled by SPC for distribution.

9. Seeker Requirements

SPC was tasked to assess target acquisition/terminal guidance sensor developments of interest to both DARPA and the Army Materiel Development and Readiness Command (DARCOM). The objective was to identify programs that could be developed jointly or concurrently and thereby provide a substantially improved or new capability.

SPC conducted an examination of recognized deficiencies, needs, and development plans in 11 mission and technology areas. Five of these areas were determined to present DARPA with opportunities for target acquisition and terminal guidance technology developments: close combat, air defense, and fire support (mission areas); and fire control and microelectronics (technology areas).

SPC examined the threat against which these technologies would be targeted and determined that they would provide a significant response to the identified deficiencies. As a result of this work, nine programs were reported as being suited to development jointly and concurrently by DARPA and DARCOM. This work is documented in SPC Report 766, Selected Target Acquisition and Terminal Guidance Sensor Technology Development Opportunities.

10. Focal Plane Array Imaging Sensors

The purpose of this task was to survey and review the relative merits of the 3-5 and 8-12 μm wave bands for focal plane array imaging sensors operating in a staring mode. The assessment also addressed considerations relative to tactical applications. The survey was based on published and unpublished data as well as information obtained from leading technical authorities in government laboratories and in industry.

The examination focused on three interrelated technical areas in which the wave bands would be employed: target and target scene emissivities, atmospheric transmissivities, and infrared (IR) focal plane array technology. The report on this task concludes that focal plane arrays operating in the 8-12 μm wave band offer the best potential for imaging seekers requiring the greatest performance under the most severely demanding conditions. However, focal plane arrays operating in the 3-5 μm wave band have the potential for adequate performance for certain tactical applications and have the advantages of earlier availability, lower risk and cost, and less sensitivity to aperture constraints.

Details of this work are presented in SPC Report 767, Survey Comparing Relative Merits of Focal Plane Array Sensors Operating in the 3-5 μm and 8-12 μm Wave Bands.

11. Tactical Air Defense

The objective of this task was to establish candidate low-cost technologies that can be applied to the target acquisition, target and intercept missile tracking, and terminal guidance functions of future tactical air defense systems. Work focused on digital beam forming and related technologies currently under development at MICOM and DARPA.

SPC conducted a review of future Army air defense requirements with MICOM representatives. This provided the inputs required to formulate a tentative DARPA/TTO development plan, the objective of which is to determine the feasibility and practicality of a multifunction, multimode, all-digital radar that combines battlefield LOMAD/SHORAD operations. It is expected that this development will demonstrate a substantial increase in performance and survivability, a reduction in manpower requirements and cost, and increased reliability. The development plan should emphasize the application of very large scale integrated circuit/very high speed integrated circuit design, adaptive digital beam forming, and development of real-time computer algorithms.

This work is documented in the SPC paper, Tactical Air Defense Technology Study.

D. DOCUMENTATION

The following documents were prepared by SPC and submitted to DARPA under this contract. In addition, SPC provided briefings and other support as required.

Behind Armor Lethal Effects (U), Letter Report, January 1981, CONFIDENTIAL.

A Report of Results of Critical Review of the Advanced Close Combat System (ACCS), SPC Report 688, January 1981, UNCLASSIFIED.

An Overview: Self-Propagating, High-Temperature Synthesis of Refractory Compounds, February 1981, UNCLASSIFIED.

"DARPA FY 1982 Research and Development Program Summary Statement" (U), March 1981, SECRET.

An Assessment of Technologies for Simulation of Indirect Fire, SPC Report 687, March 1981, UNCLASSIFIED.

Aircraft Undersea Sound Experiments (AUSEX) (U), March 1981, SECRET.

Self-Initiated Anti-Aircraft Missile (SIAM) and Undersea Sound Experiments (AUSEX), A Bibliography, SPC Report 703, April 1981, UNCLASSIFIED.

Synthesis of Advanced Materials, April 1981, UNCLASSIFIED.

Long-Range Area Air Defense System (LORAADS) Concept Study (U), SPC Report 714, June 1981, SECRET/NO FOREIGN DISSEMINATION.

Review of the Raytheon AIFS Seeker Development (U), July 1981, CONFIDENTIAL.

A Technical Evaluation of Industry Responses to the Rocket/Missile Solution of the Division Support Weapon System (DSWS), SPC Report 720, July 1981, UNCLASSIFIED.

Advanced Anti-Submarine Weapons (U), September 1981, SECRET.

Advanced Obscurants Research and Development (U), SPC Report 751, September 1981, CONFIDENTIAL.

Selected Target Acquisition and Terminal Guidance Sensor Technology Development Opportunities (U), SPC Report 766, November 1981, CONFIDENTIAL.

Survey Comparing Relative Merits of Focal Plane Array Sensors Operating in the 3-5 μm and 8-12 μm Wave Bands (U), SPC Report 767, November 1981, CONFIDENTIAL.

Tactical Air Defense Technology, November 1981, UNCLASSIFIED.